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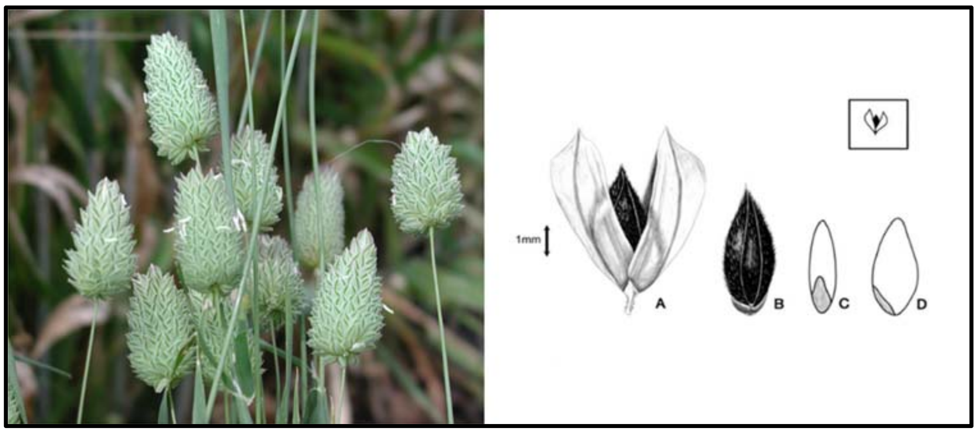
Weed Risk Assessment for *Phalaris brachystachys* Link (Poaceae) – Short-spike canary grass



Left: (Delgado, 2003). Right: A: spikelet, B: floret, C-D: caryopsis (NGRP, 2016).

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Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use the PPQ weed risk assessment (WRA) process (PPQ, 2015) to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

The PPQ WRA process includes three analytical components that together describe the risk profile of a plant species (risk potential, uncertainty, and geographic potential; PPQ, 2015). At the core of the process is the predictive risk model that evaluates the baseline invasive/weed potential of a plant species using information related to its ability to establish, spread, and cause harm in natural, anthropogenic, and production systems (Koop et al., 2012). Because the predictive model is geographically and climatically neutral, it can be used to evaluate the risk of any plant species for the entire United States or for any area within it. We then use a stochastic simulation to evaluate how much the uncertainty associated with the risk analysis affects the outcomes from the predictive model. The simulation essentially evaluates what other risk scores might result if any answers in the predictive model might change. Finally, we use Geographic Information System (GIS) overlays to evaluate those areas of the United States that may be suitable for the establishment of the species. For a detailed description of the PPQ WRA process, please refer to the *PPQ Weed Risk Assessment Guidelines* (PPQ, 2015), which is available upon request.

We emphasize that our WRA process is designed to estimate the baseline—or unmitigated—risk associated with a plant species. We use evidence from anywhere in the world and in any type of system (production, anthropogenic, or natural) for the assessment, which makes our process a very broad evaluation. This is appropriate for the types of actions considered by our agency (e.g., Federal regulation). Furthermore, risk assessment and risk management are distinctly different phases of pest risk analysis (e.g., IPPC, 2015). Although we may use evidence about existing or proposed control programs in the assessment, the ease or difficulty of control has no bearing on the risk potential for a species. That information could be considered during the risk management (decision-making) process, which is not addressed in this document.

	Phalaris brachystachys **Link – Short-spike canary grass**
Species Information	Family: Poaceae (NGRP, 2016). Synonyms: *Phalaris nitida* C. Presl, *P. quadrivalvis* Lag. (The Plant List, 2013). Common names: Confused canary grass, short-spike canary grass (NGRP, 2016). Botanical description: *Phalaris brachystachys* is an annual grass species that can grow up to 60 cm tall (Stace, 2010). It has one fertile floret that is surrounded by two significantly reduced sterile florets (Oram, 2004). The seed size is 4-5 × 1.8-2 mm (Bojňanský and Fargašová, 2007). For a full botanical description, see Anderson (1960), Baldini (1993), or Oram (2004). *Phalaris brachystachys*, *P. canariensis*, and *P. truncata* all have the chromosome number x=6. (Baldini, 1993; Voshell, 2014). These three species have been mistaken for each other due to similarities in morphology, and Baldini (1993) has questioned the validity of some records claiming to be *P. truncata*. One major difference between the three species is that *P. truncata* is a perennial, while *P. brachystachys* and *P. canariensis* are annuals. Taxonomists have debated whether *P. brachystachys* and *P. canariensis* are the same species. Baldini (1993) believed they should be treated as separate species based on caryological data. In 2004, Oram determined *P. canariensis* to be the domesticated form of *P. brachystachys* based on genetic evidence and the geographic origin of the species. In 2014, Voshell conducted more in-depth molecular and morphological experiments to conclude that *P. brachystachys* and *P. canariensis* are two separate species. This decision was supported by differences in morphology of the sterile lemmas (short and broad for *P. brachystachys*, long and narrow for *P. canariensis*) and a lack of gene flow (Voshell, 2014). For this WRA, we treated *P. brachystachys* and *P. canariensis* as two separate species. All evidence used for this assessment is based on *P. brachystachys*. If any evidence was used for *P. canariensis* to aid in answering a question, we clearly stated that the evidence was in reference to that species. Initiation: PPQ received a market access request for wheat seed for planting from the government of Italy (MPAAF, 2010). A commodity import risk analysis determined that *Phalaris brachystachys* could be associated with this commodity as a contaminant. In this assessment, we evaluated the risk potential of this species to the United States to help policy makers determine whether it should be regulated as a Federal Noxious Weed. Foreign distribution and status: *Phalaris brachystachys* is native to the Madeira Islands, Canary Islands, Northern Africa, temperate Asia, Ukraine, and southern Europe (NGRP, 2016). It is naturalized in the Azores, Germany, Denmark, and the United Kingdom (NGRP, 2016). It is

introduced in Mexico (Espinosa García, 2000) and considered a casual[1] species in Belgium (Verloove, 2006) and the Czech Republic (Pysek et al., 2002).The presence of *P. brachystachys* in Crete was questionable until a survey by Burton (1996) confirmed its presence.

U.S. distribution and status: *Phalaris brachystachys* is present in about 6 counties in California, and in about 1 county each of Oregon, Texas, Louisiana, and Missouri (Kartesz, 2015; NRCS, 2016). The status of *P. brachystachys* in Texas is currently questionable and could possibly be a misidentification (Kartesz, 2015). *Phalaris brachystachys* is considered to be naturalized in California (Peterson and Soreng, 2007). We found no evidence that *P. brachystachys* is currently being cultivated within the United States (BackyardGardener.com, 2015; Dave's Garden, 2015; Plant Information Online, 2007). We also found no evidence that it is currently being controlled or regulated (California Invasive Plant Council, 2016; Midwest Invasive Plant Network, 2016; Oregon.gov, 2016).

WRA area[2]: Entire United States, including territories.

1. *Phalaris brachystachys* analysis

Establishment/Spread Potential *Phalaris brachystachys* is an annual grass (Jimenez-Hidalgo et al., 1997; Gonzalez-Andujar et al., 2005), that is capable of completing an accelerated lifecycle (Hidalgo et al., 1990). It is a prolific seed producer (Gonzalez-Andujar et al., 2005) and requires light to germinate (Jimenez-Hidalgo et al., 1997). *Phalaris brachystachys* is self-pollinating (Oram, 2004). It has been spread unintentionally by human activity (Nelson, 1917; Ryves et al., 1996) and as a contaminant of agricultural products (Ryves et al., 1996; Verloove, 2006). *Phalaris brachystachys* (along with *P. canariensis* and *P. truncata*) has a limited natural dispersal range, and the success of its spreading has been linked to human introductions (Voshell and Hilu, 2014). Despite being successfully controlled by ACCase inhibitors, *P. brachystachys* has started to develop resistance to them (Heap, 2016). For this risk element, we had average uncertainty due to the information available on *P. brachystachys*.
Risk score = 10 Uncertainty index = 0.13

Impact Potential Very little information is known about the impacts of *P. brachystachys* on natural and anthropogenic systems. The majority of information about its impacts relate to production systems. In field experiments in Greece, *P. brachystachys* reduced wheat crop yield by 36 percent when 152 *P. brachystachys* plants were planted per square meter (Afentouli and Eleftherohorinos, 1996). *Phalaris brachystachys* has been linked to the poisoning and death of grazing sheep in Spain (de Luco et al., 1991). *Phalaris*

[1] Casual is defined by Richardson et al. (2000) as "alien plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence."
[2] "WRA area" is the area in relation to which the weed risk assessment is conducted (definition modified from that for "PRA area") (IPPC, 2012).

brachystachys is considered one of the most troublesome weeds of cereals in the Mediterranean (González-Diaz et al., 2009; Hidalgo et al., 1990) and is a weed in agricultural fields in India (Moody, 1989) and rice fields in California (USDA-FS, 1953). *Phalaris brachystachys* may impact trade, as it is a plant of environmental concern in the Republic of Palau (Space et al., 2009) and the United States is the top exporter of goods to the area (Simoes et al., 2016). It is also considered a harmful organism by the Republic of Korea (APHIS, 2016). *Phalaris brachystachys* can be controlled with the herbicides diclofop, tralkoxydim, fenoxaprop, and CGA-1849724 (Afentouli and Eleftherohorinos, 1999) and through the process of solarization (Abu-Irmaileh, 1991). Despite the early success rates of control through herbicide use, *P. brachystachys* has begun to develop resistance to ACCase inhibitors (Heap, 2016). Even though there is limited information about *P. brachystachys*' status in natural and anthropogenic systems, there was enough information about its role in agricultural systems to give us low uncertainty for this risk element.
Risk score = 2.3 Uncertainty index = 0.07

Geographic Potential Based on three climatic variables, we estimate that about 76 percent of the United States is suitable for the establishment of *Phalaris brachystachys* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *Phalaris brachystachys* represents the joint distribution of Plant Hardiness Zones 5-13, areas with 0-90 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summer, humid continental cool summer, and subarctic.

The area of the United States shown to be climatically suitable (Fig. 1) is likely overestimated since our analysis considered only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Phalaris brachystachys* is generally found in agricultural settings, pastures, and along roadsides. In Spain, *P. brachystachys* has been found to prefer loamy-sandy soils (Hidalgo et al., 1990) to heavy clay soils (Alcantara et al., 2010), an average monthly temperature of 9 °C (winter) to 27 °C (summer), and average rainfall of 463 mm to 697 mm (Hidalgo et al., 1990). However, recent experiments and field observations have shown *P. brachystachys* to have a high tolerance for water stress and become adapted to more dry conditions (Alcantara et al., 2010). See the Geographic Potential section of Appendix A for a better understanding of *P. brachystachys* preferences.

Entry Potential We did not assess the entry potential of *Phalaris brachystachys* because it is already present in the United States (Kartesz, 2015; NRCS, 2016).

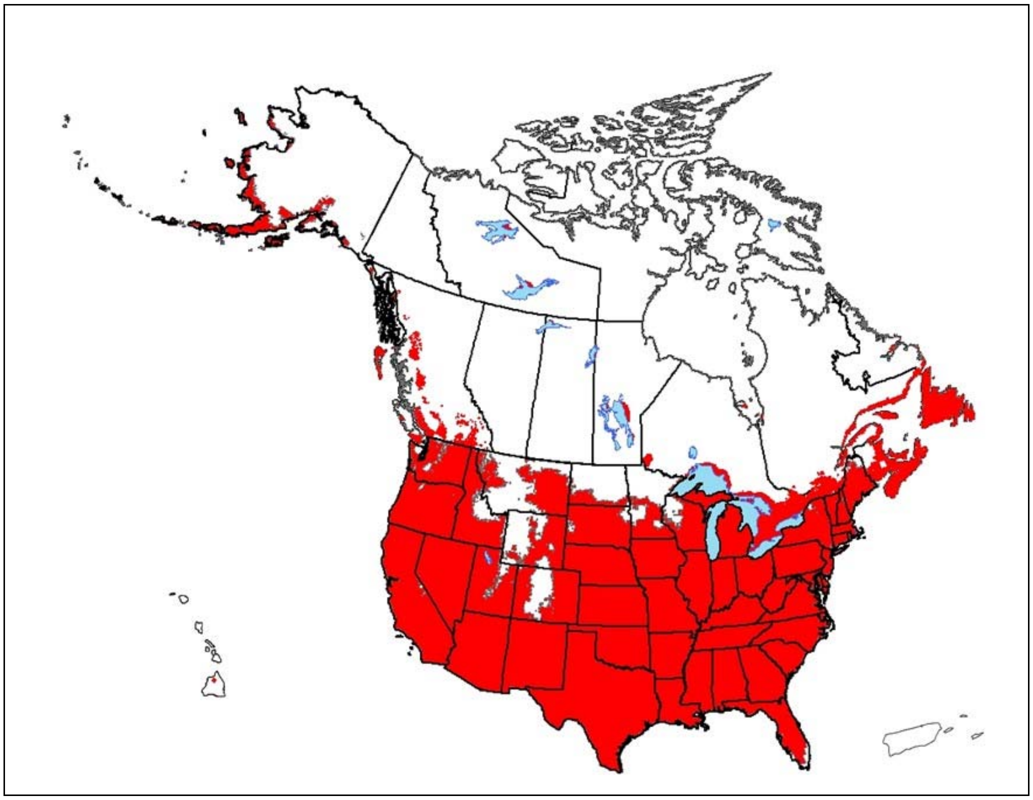

Figure 1. Potential geographic distribution of *Phalaris brachystachys* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 40.3%
P(Minor Invader) = 55.4%
P(Non-Invader) = 4.3%

Risk Result = High Risk

Secondary Screening = Not Applicable

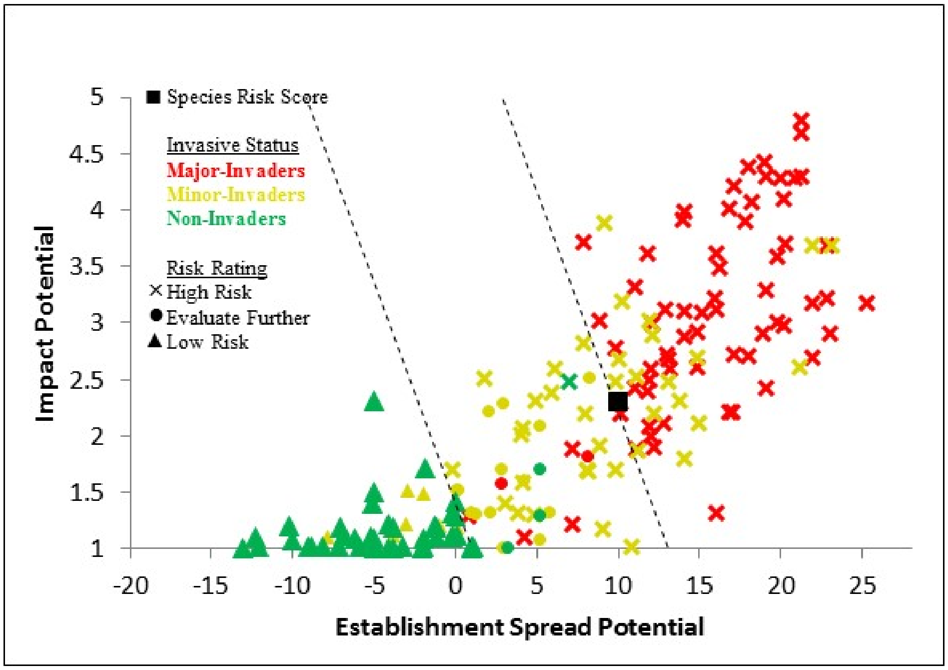

Figure 2. *Phalaris brachystachys* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

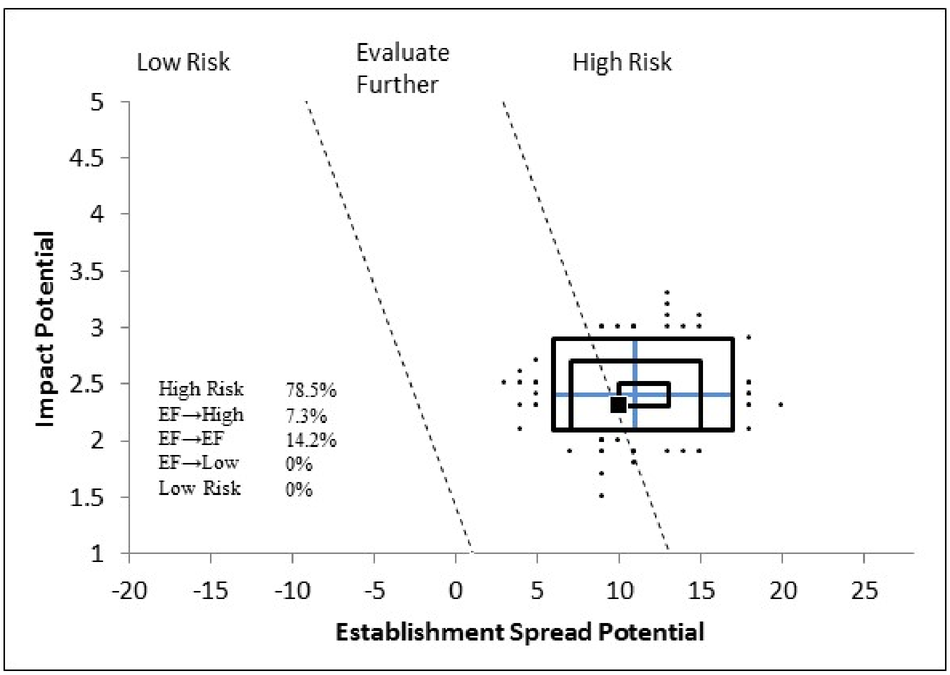

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Phalaris brachystachys*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *Phalaris brachystachys* is High Risk (Fig. 2). We are confident in our determination of high risk based on the evidence found and our low level of uncertainty through the assessment (Fig. 3). The successful spread of *Phalaris brachystachys* outside its native range has been attributed to human introduction rather than natural dispersal (Voshell and Hilu, 2014). It is a contaminant of grain (Verloove, 2006) and bird seed (Ryves et al., 1996), and has been introduced through ballast (Nelson, 1917; Ryves et al., 1996). While *P. brachystachys* is not currently cultivated in the United States (BackyardGardener.com, 2015; Dave's Garden, 2015; Plant Information Online, 2007), it is being sold online (Amazon.com, 2015; eBay, 2015) and experimented with for its potential use as a recreational drug (Shroomery: Magic Mushrooms Demystified, 2015; The Basement Shaman, 2015). Therefore, the potential spread of *P. brachystachys* could increase if there is consumer demand for this species. While *P. brachystachys* has only been implemented once in the poisoning of grazing sheep (de Luco et al., 1991), other *Phalaris* species have been repeatedly implicated in the poisoning and death of grazing livestock (Bossard et al., 2000; Bourke et al., 1990; Bourke et al., 2003; Burrows and Tyrl, 2013; Gallagher et al., 1966). *Phalaris paradoxa*, *P. minor*, *P. canariensis*, and *P. arundinacea* were suspected of causing esophageal in Iran by contaminating wheat flour (Sangster et al., 1983), but no follow up studies were found. *Phalaris brachystachys* was not part of the study in Iran.

Another potential problem for farmers is that *P. brachystachys* seeds shatter at maturity (Voshell, 2014). While *P. brachystachys* is mainly found in winter cereal crops, it can have an accelerated life cycle depending on the surrounding environment (Hidalgo et al., 1990). Therefore, farmers may have to deal with *P. brachystachys* seeds being continually reintroduced into their fields, making control difficult. To further complicate things, *P. brachystachys* has recently developed resistance to ACCase inhibitor herbicides in Italy and Iran (Heap, 2016). Other species of *Phalaris*, such as *P. paradoxa*, have also recently developed herbicide resistance (Hochberg et al., 2009; Valverde, 2007). While *P. brachystachys* is already present in the United States, its distribution is restricted (NRCS, 2016). However, its recent resistance to herbicides, its ability to adapt to different environmental conditions, and its potential popularity as a recreational drug may encourage its spread within the United States.

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Appendix A. Weed risk assessment for *Phalaris brachystachys* Link (Poaceae). Below is all of the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file, where this assessment was conducted, is available upon request.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	e - low	5	*Phalaris brachystachys* is native to the Madeira Islands, Canary Islands, Northern Africa (Algeria, Libya, Morocco, Tunisia), temperate Asia (Saudi Arabia, Azerbaijan, Tajikistan, Turkmenistan, Uzbekistan, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Syria, Turkey), Ukraine, southern Europe (Albania, Croatia, Greece, Italy, Slovenia, France, Portugal, Spain) (NGRP, 2016). It is naturalized in the Azores, Germany, Denmark, and the United Kingdom (NGRP, 2016). It is introduced in California, Oregon, Texas, Louisiana, and Missouri in the United States (NRCS, 2016), as well as in Mexico (Espinosa García, 2000). It is a casual species in Belgium (Verloove, 2006) and the Czech Republic (Pysek et al., 2002). The presence of *P. brachystachys* in Crete was questionable until a survey by Burton (1996) confirmed its presence. In the Andalusia region of Spain, *P. brachystachys* has extended its range from irrigated fields with heavy clay soils to semiarid provinces with low rainfall (Alcantara et al., 2010).
ES-2 (Is the species highly domesticated)	n - negl	0	Selective breeding by humans within the genus *Phalaris* is rare (Voshell and Hilu, 2014). We found no evidence that it has been domesticated or bred for traits conferring reduced weed potential. Because we found no evidence that it is currently being cultivated, we used negligible uncertainty.
ES-3 (Weedy congeners)	y - negl	1	The genus *Phalaris* consists of approximately 22 species (Baldini, 1995). Randall (20122012) lists approximately 16 species of *Phalaris* as weeds ranging from being invasive to being an environmental or agricultural weed. *Phalaris aquatica*, *P. tuberosa*, and *P. paradoxa* have all been found to be toxic to sheep resulting in heart disease to death (Bossard et al., 2000; Bourke et al., 1990; Bourke et al., 2003; Gallagher et al., 1966). *Phalaris arundinacea* is a major invader (Weber, 2003) and is a threat to wetland ecosystems (Apfelbaum and Sams, 1987).
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	*Phalaris brachystachys* is mainly found in waste grounds, on edges of cultivated fields, and along roadsides (Baldini, 1993; Baldini, 1995), all of which are high light environments. Jimenez-Hidalgo et al. (1997) found *P. brachystachys*,

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
			along with *P. paradoxa* and *P. minor*, to prefer light for germination.
ES-5 (Climbing or smothering growth form)	n - negl	0	*Phalaris brachystachys* is not a vine or plant that forms basal rosettes; it is a grass that can grow up to 60 cm tall (Stace, 2010).
ES-6 (Forms dense thickets)	n - low	0	We found no evidence that *Phalaris brachystachys* forms dense thickets, patches, or populations.
ES-7 (Aquatic)	n - negl	0	*Phalaris brachystachys* is not an aquatic plant. It is a terrestrial herb (NGRP, 2016).
ES-8 (Grass)	y - negl	1	It is a grass and a member of the Poaceae family (NGRP, 2016).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that *P. brachystachys* is a nitrogen-fixing plant. It is not a member of a plant family known to contain nitrogen-fixing species (Martin et al., 2006; Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	*Phalaris brachystachys* reproduces through seed production. One mature plant of *P. brachystachys* can produce approximately 1,012 seeds (Jimenez-Hidalgo et al., 1997). The seeds have a 16 percent emergence rate (Jimenez-Hidalgo et al., 1997).
ES-11 (Self-compatible or apomictic)	y - low	1	Experimental studies by Voshell (2014) showed *P. brachystachys* to be self-compatible.
ES-12 (Requires special pollinators)	n - negl	0	*Phalaris brachystachys* is self-pollinating (Oram, 2004).
ES-13 [What is the taxon’s minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - low	1	*Phalaris brachystachys* is an annual (Voshell, 2014). Typically, *P. brachystachys* is found in winter cereal crops, but has been found in summer crops in Spain and is capable of completing an accelerated life cycle (Hidalgo et al., 1990). The alternate answers for the uncertainty simulation are "a" and "c."
ES-14 (Prolific reproduction)	y - negl	1	Afentouli and Eleftherohorinos (1996) found the average number of seeds per panicle for *P. brachystachys* to be 190. Gonzalez-Andujar et al. (2005) found *P. brachystachys* to produce an average of 6.26 panicles per plant with an average of 196.8 seeds per panicle. One mature plant of *P. brachystachys* can produce approximately 1,012 seeds (Jimenez-Hidalgo et al., 1997). The seeds have a 16 percent emergence rate (Jimenez-Hidalgo et al., 1997). During this same field study, Gonzalez-Andujar et al. (2005) found *P. brachystachys* to produce an average of 16.70 seedlings per meter^2. “Total seed production per square meter (seed rain) was 5,392 in 1988 and 25,101 in 1990” (Gonzalez-Andujar et al., 2005).
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	1	It was collected from ballast grounds along the Pacific coast in Portland, OR, which is considered a "port of entry" for species (Nelson, 1917). *Phalaris brachystachys* has been a casual

Question ID	Answer - Uncertainty	Score	Notes (and references)
			introduction of ballast and docks in the British Isles (Ryves et al., 1996).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	It has been introduced as a contaminant of grain into Belgium (Verloove, 2006) and the British Isles (Ryves et al., 1996). It has also been introduced into the British Isles in birdseed (Ryves et al., 1996). *Phalaris brachystachys* and *P. truncata* are often confused due to their similarities in morphology, which calls into question the reliability of literature records (Baldini, 1993; Baldini, 1995).
ES-17 (Number of natural dispersal vectors)	0	-4	Fruit and seed description for ES-17a through ES-17e: one fertile floret surrounded by two sterile florets; fertile floret 4.4-5.5 mm long and 1.3-1.8 mm wide; sterile florets significantly shorter than fertile floret (0.6-1.2 mm long), glabrous with tufts of hair at base (Anderson, 1960). It is the only annual with "sterile florets that are swollen and shaped like nectaries" (Anderson, 1960).
ES-17a (Wind dispersal)	? - max		*Phalaris* species with sterile side spikelets are adapted for wind dispersal (Gal and Alexandre, 2000). *Phalaris brachystachys* disperses its caryopses by shattering to the ground (Matus-Cadiz and Hucl, 2002). We found no direct evidence that P. brachystachys is wind dispersed. Therefore, we answered unknown with max uncertainty.
ES-17b (Water dispersal)	n - negl		We found no evidence that *P. brachystachys* is water dispersed.
ES-17c (Bird dispersal)	? - max		Unknown. We found no evidence that *P. brachystachys* is dispersed by birds.
ES-17d (Animal external dispersal)	n - low		We found no evidence that *Phalaris brachystachys* can be dispersed by animals, and it is well studied.
ES-17e (Animal internal dispersal)	? - max		Despite *P. brachystachys* being moderately grazed in Northeastern Israel (Noy-Meir et al., 1989) and consumed by sheep in Spain (de Luco et al., 1991), there is no evidence that the seeds can pass through these animals in a way that would aid in their dispersal.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - high	1	Jimenez-Hidalgo et al. (1997) found that seeds of *Phalaris* species enter a primary dormancy that lasts for a few months and a spike in germination occurs after 12 months. It was also noted that some seeds can remain viable after 18 months (Jimenez-Hidalgo et al., 1997). Taylor et al. (2005) found during seed burial experiments for *P. paradoxa* (an annual) that 10 percent of the remaining seeds were still viable after one year. We answered yes with high uncertainty because no direct evidence was found for *P. brachystachys*, but evidence of a persistent seed

Question ID	Answer - Uncertainty	Score	Notes (and references)
			bank for other annual *Phalaris* species is available.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - low	-1	We found no evidence that *P. brachystachys* benefits from mutilation, cultivation, or fire.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	y - negl	1	Recent reports from Iran and Italy have found *Phalaris brachystachys* to be resistant to ACCase inhibitors such as clodinafop-propargyl, diclofop-methyl, fenoxaprop-P-ethyl, and haloxyfop-methyl (Heap, 2016).
ES-21 (Number of cold hardiness zones suitable for its survival)	9	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	8	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence that *Phalaris brachystachys* is allelopathic. Gitsopoulos et al. (2013) experimentally showed a reduction in germination and root length of *P. brachystachys* after exposure to essential oils from *Satureja hortensis* and *Melissa officinalis*. Experimental studies by Uremis et al. (2009) showed various plant essential oils to have inhibitory effects on *P. brachystachys* germination. Evidence has shown *P. paradoxa* to be affected by other plant's allelopathy (Al-Sherif et al., 2013; Singh et al., 2003).
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that *Phalaris brachystachys* or its congeners are parasitic; the family Poaceae is not known to contain parasitic plants (Nickrent, 2016; Nickrent and Musselman, 2004).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - low	0	*Phalaris brachystachys* is mainly a weed of agriculture systems (Afentouli and Eleftherohorinos, 1996; Alcantara et al., 2010; Baldini, 1995; Gonzalez-Andujar et al., 2005). Because we found no evidence that it naturalizes or is weedy in natural systems, we used low uncertainty for all questions in this sub-element. We found no direct evidence that *P. brachystachys* changes ecosystem processes and parameters.
Imp-N2 (Change community structure)	n - low	0	We found no evidence that it changes habitat structure.
Imp-N3 (Change community composition)	n - low	0	We found no evidence that it changes species diversity.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	n - low	0	Because we found no evidence that this species invades natural areas, it is unlikely it will affect any federal threatened and endangered species. We note that there is some evidence that this

Question ID	Answer - Uncertainty	Score	Notes (and references)
			species is toxic (Burrows and Tyrl, 2013; de Luco et al., 1991); however, it is beyond the scope of this WRA to evaluate any potential impacts to threatened or endangered animals that may or may not graze this grass.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	n - low	0	It is unlikely that it will affect U.S. globally outstanding ecoregions.
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that this species is weedy in natural systems, let alone being controlled in them. Currently, the only evidence of control is in relation to agricultural systems. The alternate answers for the uncertainty simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - low	0	*Phalaris brachystachys* has been found along roadsides (Baldini, 1993), but we found no evidence that it negatively impacts personal property, human safety, or public infrastructure. Currently, the majority of information about *P. brachystachys* focuses on its presence in agricultural systems. For this reason, we used low uncertainty for this question and the remaining questions in this sub-element.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence that *Phalaris brachystachys* changes or limits recreational use of an area.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - low	0	We found no evidence that *Phalaris brachystachys* affects desirable and ornamental vegetation.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - low	0	Despite the presence of *P. brachystachys* along roadsides, there is no direct evidence that it is considered a weed in anthropogenic systems. Therefore, we answered "a" with low uncertainty. The alternate answers for the uncertainty simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	Field experiments in Greece showed a reduction of wheat by 36 to 42 percent when *P. brachystachys* or *P. minor* were planted at 152 and 304 plants per meter squared (Afentouli and Eleftherohorinos, 1996). Jimenez-Hidalgo et al. (1997) found a reduction in wheat yield by 16 percent, when *P. brachystachys* was planted a 100 plants per meter squared.
Imp-P2 (Lowers commodity value)	? - max		Despite evidence of *P. brachystachys* lowering commodity yield (Afentouli and Eleftherohorinos, 1996) and being toxic to sheep (de Luco et al., 1991), we found no evidence that it lowers commodity value or decreases the value of livestock. In addition, we found no evidence that this species is susceptible to ergot-

Question ID	Answer - Uncertainty	Score	Notes (and references)
			producing fungi. Therefore, we answered unknown with max uncertainty.
Imp-P3 (Is it likely to impact trade)	y - mod	0.2	*Phalaris brachystachys* is considered to be a plant of environmental concern to the Republic of Palau and is included on a list of plants that should be quarantine or immediately eradicated if found (Space et al., 2009). Since the United States is one of the top countries importing goods to the Republic of Palau (Simoes et al., 2016), the presence of *P. brachystachys* in commodities may impact trade, so we answered yes with moderate uncertainty.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no direct evidence that *P. brachystachys* affects irrigation or strongly competes with plants for water.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - low	0.1	In Spain, sheep suspected of poisoning by *P. brachystachys* showed symptoms ranging from neurological distress to death (de Luco et al., 1991). Autopsies of the sheep revealed a high consumption of *P. brachystachys*, which was evidenced by the number of seeds found within their stomachs (de Luco et al., 1991). We found no other evidence about toxicity for this species, but other species from this genus have been found to be toxic (Burrows and Tyrl, 2013).
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.6	*Phalaris brachystachys* is considered to be one of the most troublesome weeds of cereals in Mediterranean climates (González-Diaz et al., 2009). In Spain, it ranges from medium to high infestation rates in *Triticum aestivum*, *Helianthus annuus*, *Beta vulgaris*, *Vicia faba*, *Allium sativum*, and *Cicer arietnum* (Hidalgo et al., 1990). It is considered a weed of rice fields in California (USDA-FS, 1953) and India (Moody, 1989). Field experiments in Greece in the early 1990s showed almost 100 percent control of *P. brachystachys* by diclofop, tralkoxydim, fenoxaprop, and CGA-184927 (Afentouli and Eleftherohorinos, 1999). Soil solarization in the Jordan Valley successfully reduced the dry weight *P. brachystachys* in squash and tomato fields (Abu-Irmaileh, 1991).
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (Kartesz, 2015).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z5 (Zone 5)	y - mod	N/A	Iran (Mirkamali, 1987).
Geo-Z6 (Zone 6)	y - low	N/A	Czech Republic (Pysek et al., 2002). Iran (Mirkamali, 1987).
Geo-Z7 (Zone 7)	y - negl	N/A	France, Italy (GBIF, 2016). Czech Republic (Pysek et al., 2002). Iran (Mirkamali, 1987). Missouri (NRCS, 2016).
Geo-Z8 (Zone 8)	y - negl	N/A	Greece, Morocco, Spain, France, Belgium, Germany, Switzerland (GBIF, 2016). Iran (Mirkamali, 1987). United States (OR, LA) (NRCS, 2016).
Geo-Z9 (Zone 9)	y - negl	N/A	Syria, Greece, Morocco, Portugal, Spain, France, Italy, United States (CA) (GBIF, 2016). Iran (Mirkamali, 1987). United States (TX, LA) (NRCS, 2016).
Geo-Z10 (Zone 10)	y - negl	N/A	Jordan, Israel, West Bank, Lebanon, Syria, Greece, Morocco, Portugal, Spain, France, Italy, United States (CA) (GBIF, 2016). Iran (Mirkamali, 1987).
Geo-Z11 (Zone 11)	y - negl	N/A	Australia, Israel, West Bank, Greece, Spain, Morocco, Portugal, Italy, United States (CA) (GBIF, 2016).
Geo-Z12 (Zone 12)	y - negl	N/A	Israel (lots of points), Canary Islands.
Geo-Z13 (Zone 13)	? - max	N/A	Canary Islands (one point).
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Morocco, Spain, Greece, Jordan, Israel (GBIF, 2016). Iran (Mirkamali, 1987). United States (TX) (NRCS, 2016).
Geo-C4 (Desert)	y - negl	N/A	Spain, Israel (GBIF, 2016). Iran (Mirkamali, 1987).
Geo-C5 (Mediterranean)	y - negl	N/A	Australia, United States (CA), Spain, Morocco, Portugal, France, Italy, Greece, Israel, West Bank, Syria, Lebanon (GBIF, 2016). Iran (Mirkamali, 1987). United States (OR) (NRCS, 2016).
Geo-C6 (Humid subtropical)	y - negl	N/A	Spain (one point) (GBIF, 2016). United States (TX) (NRCS, 2016).
Geo-C7 (Marine west coast)	y - negl	N/A	France, Belgium, Germany.
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	Missouri (NRCS, 2016).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	France, Italy, Switzerland (GBIF, 2016). Czech Republic (Pysek et al., 2002).
Geo-C10 (Subarctic)	y - mod	N/A	France (four points).
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	United States (CA), Spain, Jordan, Israel, West Bank (GBIF, 2016). Iran (Mirkamali, 1987).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	United States (CA), Spain, Morocco, Portugal, France, Italy, Greece, Israel, West Bank, Syria (GBIF, 2016). Iran (Mirkamali, 1987).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	United States (CA), Morocco, Portugal, Spain, France, Italy, Greece, Israel, Syria, Lebanon (GBIF, 2016). Iran (Mirkamali, 1987). Czech Republic (Pysek et al., 2002). United States (TX) (NRCS, 2016).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	United States (CA), Morocco, Portugal, Spain, France, Belgium, Italy (GBIF, 2016). Iran (Mirkamali, 1987). Czech Republic (Pysek et al., 2002). United States (TX) (NRCS, 2016).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Spain, France, Switzerland, Germany, Italy (GBIF, 2016). Czech Republic (Pysek et al., 2002). United States (MO) (NRCS, 2016).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Spain, France (GBIF, 2016). Czech Republic (Pysek et al., 2002). United States (LA) (NRCS, 2016).
Geo-R7 (60-70 inches; 152-178 cm)	? - max	N/A	We found no evidence that it occurs in this precipitation band. However, it does occur in precipitation bands below and above this one, so we answered yes with high uncertainty.
Geo-R8 (70-80 inches; 178-203 cm)	y - high	N/A	Italy (one point).
Geo-R9 (80-90 inches; 203-229 cm)	y - low	N/A	Australia (one point) (GBIF, 2016GBIF, 2016). United States (OR) (_ENREF_49NRCS, 2016).
Geo-R10 (90-100 inches; 229-254 cm)	n - negl	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	n - negl	N/A	We found no evidence that it occurs in this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Because *P. brachystachys* is already present in the United States (NRCS, 2016), we did not evaluate its entry potential.
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other pathway)	-	N/A	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	